Module 6 - Steady State Circuits

ME3023 - Measurements in Mechanical Systems

Mechanical Engineering

Tennessee Technological University

Topic 2 - Fundamental Laws

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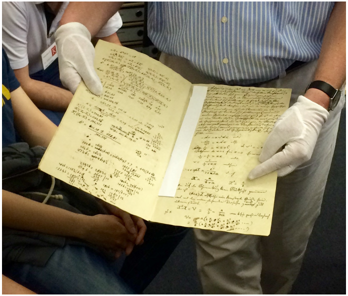
- Ohm's Law
- Kirchhoff's Laws
- Power Dissipation
- Example: Resistance Sensor

Ohm's Law

George Simon Ohm

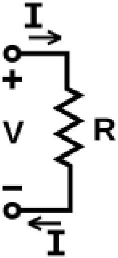


Ohm did his work on resistance in the years 1825 and 1826, and published his results in 1827 as the book Die galvanische Kette, mathematisch bearbeitet...

Ohm's Law

Ohm's law states that the current through a conductor between two points is directly proportional to the voltage across the two points.

$$I = \frac{V}{R}$$



It is more commonly shown in the following form.

$$V = IR$$

Kirchhoff's Laws

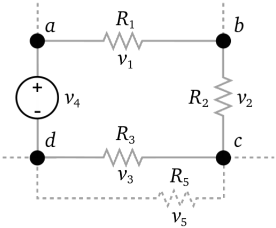
Both of Kirchhoff's laws can be understood as corollaries of Maxwell's equations in the low-frequency limit. They are accurate for DC circuits, and for AC circuits at frequencies where the wavelengths of electromagnetic radiation are very large compared to the circuits.

1. Kichhoff's Voltage Law (KVL)
2. Kichhoff's Current Law (KCL)

Kirchhoff's Laws

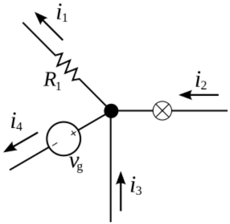
Kichhoff's Voltage Law (KVL) - The sum of the voltages around a loop (aka mesh) equals zero.

$$\sum_{k=1}^{n} V_k = 0$$



Kichhoff's Current Law (KCL) - The sum of the current flowing in and out of node (aka junction) equals zero.

$$\sum_{k=1}^{n} I_k = 0$$



Power Dissipation

Energy is transformed in to heat in passive circuit components. For a resistor the power dissipation can be found with following relations.

$$P = IV \qquad V = IR$$

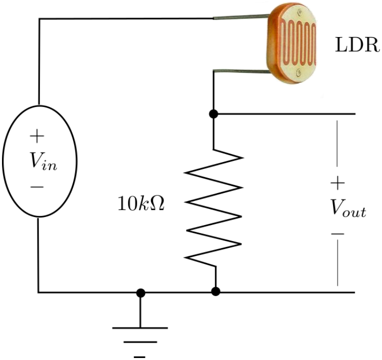
Power Dissipation

Power is the rate of energy dissipated, aka the amount of energy lost per unit of time. How do we compute total energy for the power?

$$E = \int_{t1}^{t2} P dt$$

Example: Resistance Sensor

Consider the simple circuit shown for measuring light intensity.



1. Find the current in the loop.
2. Find the voltage drop across the LDR.
3. Find the voltage drop across the $10k\Omega$ resistor.
4. Find the power dissipated in the resistor and the total energy lost to heat over 10 seconds.

Example: Resistance Sensor